Public Health Evaluation of Vapor Intrusion Exposures: Examples of Key Issues and Cases from the Mid-Atlantic Region.

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ABSTRACT

Vapor Intrusion (VI) is the process of gases, generally volatile organic compounds (VOCs), migrating from contaminated subsurface soil and groundwater into the indoor air of overlying or nearby buildings. VI is a growing public health concern in the Mid-Atlantic region, with the number of VI sites under public health evaluation in the region increasing over the past 3 years. Environmental and public health agencies are evaluating and re-evaluating a number of groundwater- contaminated sites in Region 3 to determine if completed exposure pathways for subsurface vapor intrusion into indoor air exist. This poster presents some of the public health questions and issues at sites with the potential for VI: What are the preferred environmental data to perform a public health evaluation at a VI site? How do we evaluate health exposures at a VI site? What are our public health recommendations? How do we communicate public health issues at VI sites to community members? In addition, this poster highlights site-specific issues via three case examples of VI sites undergoing public health evaluation in Region 3.

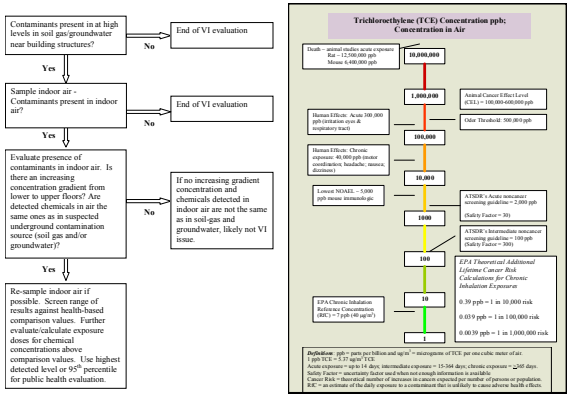
What Information is Preferred for a Public Health Evaluation of a Vapor Intrusion Site?

Indoor Air - **Indoor air data are preferred for calculating exposure doses and making a definitive public health determination.** Due to seasonal variations, usually more than one round of indoor air data is preferred to increase confidence in the results. In addition, ATSDR R3 and PADOH find it helpful to have information on background air levels (i.e., non-VI-related internal and external air contamination sources) affecting the building(s) undergoing sampling to provide context when evaluating the indoor air data.

Soil Vapor - If contaminants are detected in soil vapor or subslab soil vapor at high concentrations, ATSDR R3 and PADOH may consider the site a *potential* public health hazard even when no indoor air results are available to evaluate. However, ATSDR R3 and PADOH will not make a definitive public health determination based solely on soil vapor data, because this information does not reflect actual exposures to community members.

Groundwater - Similarly, if contaminants in groundwater are at high concentrations and site conditions indicate that the depth of the water table and/or distance to the contaminated ground water is close (and/or that contaminated groundwater is directly accessible such as through collected water in a basement sump pump), ATSDR R3 and PADOH may consider the site a *potential* public health hazard for the VI pathway even when no indoor air results are available to evaluate.

How Do We Evaluate Exposures?



Evaluating exposures continued…

The potential for harmful health effects is related to the chemical, the dose and the exposure pathway. Dose is the amount of a chemical taken into the body over time and how it is absorbed. We evaluate "dose" to community members, which is based on how long and to what amount of the chemical people are or were exposed. Then we determine the risk for cancer and other health risks and the likelihood that the exposure caused disease.

Issues for consideration when evaluating public health effects from VI exposures:

1) Multiple exposure pathways: In addition to evaluating exposure due to VI, we evaluate ingestion (drinking contaminated water) and inhalation due to the volatilization of contaminants while showering and doing other household activities.

2) Calculating doses: Doses depend on the concentration of the chemical (how much) and the length of exposure (how long). ATSDR R3 and PADOH use site-specific information to estimate exposure durations for each unique situation. If this specific information is not available (e.g., when exposures throughout a community are being considered and the dose and/or duration of exposures in the past are unknown), ATSDR R3 and PADOH may conservatively assume a lifetime (70 year) exposure duration.

- Exposure doses are carefully reviewed to known health effect levels (e.g., see thermograph for TCE health effects in this section). Conservative health guidelines and assumptions are used in order to reach the most protective conclusions and recommendations.
- It is often very difficult to determine if someone has gotten sick from a site, even if they have been exposed. Past exposures are often hard to determine. There are often other factors, acting alone or together, that might increase someone's risk of illness, such as exposure to cigarette smoke, family history, age, sex, diet, or his or her occupation. Some illnesses such as cancer are known to have a long latency period, sometimes decades. Some illnesses can be caused by changes that occurred in your body a long time ago.

Case Study 1-Mixed VOCs Site

Sub-slab soil gas and indoor air samples (SUMMA) were collected from a residence located close to two industrial sites contaminated with PCE, TCE and BTEX. Subslab soil vapor and indoor air results were collected; results for PCE were as follows:

Sample Location	PCE Sample Results (ppb)
Residence's Sub-slab soil gas results	52,000 ppb
Indoor Air Sample Results – Basement samples four locations (summa)	0.20, 0.28, 0.5, 5.0
Indoor Air Sample Results - First floor samples, four locations	0.30, 0.31, 0.49, 0.31

Public Health Issues for this Site: How many rounds of sampling should be conducted? Is the apparent lack of vapor intrusion into the residence a stable, long term situation? What are the implications for mixtures of contaminants at a site?

Public Health Conclusions and Recommendations for this Site: Despite very high subslab vapor results under the home, residential indoor air results are low and below short duration health effect levels. Further monitoring and assessment under a environmental agency remedial program is warranted to address potential long term exposure concerns.

Case Study 2-PCE Site

Indoor air samples revealed the presence of PCE in indoor air of an active day care operation in an urban area. Next door to the day care is an operating dry cleaner. Indoor air samples collected with SUMMA canisters revealed the following concentrations:

Sample Location	PCE Sample Results (ppb)
Basement – indoor air results (summa)	92 ppb
First floor indoor air results (summa)	29 ppb, 19 ppb, 26 ppb
Outside ambient air (summa)	8.6 ppb

Public Health Issues for this Site: Special consideration is needed for the sensitive populations at this site. What is the most appropriate sampling height for very young children and infants? What exposure durations would be relevant? How representative are these results? What additional sampling is needed (note only air data was collected; no soil vapor or groundwater information available at this time)? What is the status of the existing air treatment/ventilation system at the day care?

Public Health Conclusions and Recommendations for this Site: PCE levels detected in indoor air at the location do not pose an acute health threat to the exposed population based on this single round of sampling; however conditions may change in the future and a further chronic evaluation is needed (note day care currently not operating due to license issues). Additional testing of indoor air is needed. If contaminants continue to be detected, provide ventilation and resample the air. Further characterization of the full extent of the suspected groundwater plume and other potential affected receptors/buildings is needed.

Case Study 3-TCE Site

TCE contamination was detected in soil and groundwater on an industrial property in a residential area.

What environmental data were collected?

1) Soil vapor collected from randomly selected residential yards and businesses
2) Sub-slab soil vapor was collected depending on the results from the soil vapor samples. Vapors were collected from underneath homes
3) Indoor air was collected depending on sub slab sample results.

Round #1: Indoor Air SUMMA Canisters

Home #1	Home #2
8 ppb basement	11 ppb basement
1 ppb first floor	21 ppb first floor
Single father and teenage son	Husband and pregnant wife

Round #2: Indoor Air SUMMA Canisters/TAGA Bus

Home #1	Home #2
Teen's room in basement	42 ppb basement
ND basement	6.7 ppb first floor
ND first floor	ND front porch
ND front porch	

Round #3: Indoor Air SUMMA Canisters/TAGA Bus

Home #1	Home #2
11 ppb basement (sump)	21 ppb basement (drain)
8.6 ppb basement (center at 4' height)	9 ppb basement drain
1 ppb first floor (4' height)	3 ppb first floor
ND front porch	ND 2nd floor and front porch

Public Health Issues for this Site:
Should the same action levels be used at the two residences even though the susceptibility of the receptors is different (adults vs. pregnant woman)? What is considered a "representative sample" – how much indoor air sampling is needed? What exposure duration do the sample results represent (e.g., one day, one year, 30 years? Will site conditions change (e.g. cracks in foundation, remodeling of the house)? If so, will changes increase/decrease potential exposures related to the VI pathway in the future?

Public Health Conclusions and Recommendations for this Site: Install vapor abatement systems at residential structures meeting site-specific indoor air sampling criteria supported by an ATSDR Health Consultation, and conduct one year of post construction quarterly monitoring (indoor air, soil gas, surface water, and groundwater).

What Are Our Public Health Recommendations at VI Sites?

Depending on site specific conditions, public health agencies can recommend: no further action, additional monitoring, and/or mitigation/remediation of VI sites. To be conservative, public health conclusions and follow-on recommendations are often made based on the highest detected concentrations found in the indoor air at a site; however, uncertainty remains regarding what indoor air concentrations will occur in the future if the contamination source is not remediated. Public health recommendations should consider and be protective of future scenarios that might involve sensitive populations such as small children, women of childbearing age, the elderly, etc.

How Do We Communicate Public Health Concerns To Community Members at VI Sites?

Methods and Techniques for Public Health Communication at VI Sites

- Transparency is vital – It is important to reach out to and engage community members from the beginning of a VI investigation. This exposure pathway involves complex environmental concepts and often involves negotiating the personal property of residents.
- Keep the communications lines open -- Prepare periodic newsletters or establish a website with up-to-date site information that includes information from the health perspective. Share information with the health professional community serving the site area, as needed.
- Be prepared to discuss the contributions of household chemical sources to indoor air contamination.
- Use visual aids (see thermograph in the evaluation section) to talk with community members about the levels of chemicals detected in their indoor air, and discuss how these levels compare to levels known to cause adverse health effects.
- Work in parallel with environmental agencies, and provide communications that bridge both the environmental regulatory risk assessment and the public health assessment approaches.

Acknowledgements:

The authors gratefully acknowledge the community members who have invited us into their homes and worked with us as we have evaluated VI sites in the region, as well as the work of Dr. Karl Markiewicz, ATSDR R3 senior toxicologist, who developed the TCE thermograph displayed in this poster and provided information for the case studies.